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REPORT OF SIX MONTHS' WORK OF THE EXPEDITION TO BAGDAD ON THE SUBJECT OF ORIENTAL SORE.[1]

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BAGDAD was reached in the second week in March 1910, and work was commenced as soon as suitable accommodation had been secured. There has been no lack of material, as it was soon found that the Oriental sore of Bagdad, known locally as the date boil, was a disease from which practically all inhabitants suffered at some period of their life. The vast majority of those infected, however, are very young children of from 1 to 3 years, and some time elapsed before a case suitable for the conduction of experimental work was found. The investigations so far conducted may best be described under the following headings :—

(1) The characters and course of the disease in man.

(2) The examination of lower animals for signs of the disease and inoculation of these from man.

(3) Study of the various biting flies, ticks, &c., found in Bagdad.

(4) Experiments with the biting flies fed on date boil cases and dissection of flies.

(5) Examination of the date boil parasite as it occurs in the sore.

(6) Culture experiments with the date boil parasite.

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[1] From the *Report of the Advisory Committee for the Tropical Disease Research Fund for* 1910, with some verbal emendations by the Author.

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(1) The Characters and Course of the Disease in Man.

As has just been mentioned, with very few exceptions all inhabitants are infected at some period of their life. Natives of Bagdad almost invariably contract the "date boil" when young, and between the ages of 1 and 3. Newcomers from uninfected districts contract the disease most usually within the first twelve months after arrival, but in rare cases they may escape the disease for years, if not permanently. All classes of inhabitants are infected alike, and the scar left by the "date boil" and known as the "date mark" is to be seen on the face of nearly everyone. People living outside Bagdad—the Arabs in encampments and the dwellers in the smaller villages—apparently escape infection, as several cases have been encountered in young adolescents who have come into Bagdad later in life to find occupations.

Seasonal Prevalence of the Disease.—As is generally known, there is a seasonal prevalence of the disease. The "date boil" most usually makes it appearance in the autumn at the time when the dates are ripening. From this fact the name "date boil" is derived, and also one of the local theories which attributes the disease to eating dates or even to pricking by the thorns of the date palms. Such a theory cannot be entertained, since the subjects most usually infected are little children who have hardly attained the age of eating dates. Though the disease most usually makes its appearance in the months of September, October, and November, the "date boil" may develop at any season of the year. This seasonal variation in the frequency of onset of the disease must certainly depend on a parallel variation in the occurrence of some biting fly responsible for its transmission.

Position of Date Boil on the Body.—It has long been a recognized fact that the date boil appears only on exposed surfaces of the body. In very young children of about 1 year old one rarely sees a date boil except on the face. This is probably dependent

upon the habit of wrapping up infants so that the whole body is covered except the face. In children a little older the date boil is commonly seen on the arms and legs below the elbows and knees, though the face is still the most usual situation. In adults, invariably newcomers, the disease appears almost as frequently on the arms and legs as upon the face. It is rare to find a date boil in any other part of the body. I have seen one case in a boy aged about 5, where there was one boil on the buttock and another on the chest over the sternal end of the second left rib. This practically constant appearance of the date boil on the exposed surfaces of the body can only be explained by the assumption that the disease is transmitted by some biting insect which feeds upon these exposed surfaces, in contradistinction to such biting insects as body lice, fleas, and bed bugs, which prefer to suck their blood under the protection of clothing.

Number of Date Boils.—It is probably safe to state that the single sore is most commonly encountered, and this one may be on the cheek, lip, nose, eyelid, forehead, arm, hand, leg, or foot. Two, three, and even four sores are by no means uncommon, but cases with larger numbers than these are certainly rare. I have seen one case where there were eighteen sores on the face, and one on each of the limbs, with the exception of the left arm, which had two, making a total of twenty-three sores. I have been told of cases where the numbers have been even greater, but the character of the sores in these cases had not been established by microscopical examination. The question may be asked: "Is it safe to assume that, in these cases of multiple sore, each sore is the result of a separate inoculation by some biting insect?" It may be answered that in this case of multiple infection there was not a single sore on an unexposed surface.

Incubation Period.—On the subject of the incubation period it is difficult to obtain precise information.

The youngest child I have seen infected was aged 7 months. Cases of Europeans becoming infected within two months of entering the country are not uncommon, and I have obtained a reliable history of a case of two red spots appearing on the feet a fortnight after arrival. These persisted for upwards of a year, and in them I was able to find large numbers of the typical parasites. On the other hand, it is known that the disease may make its first appearance in a person many months after leaving the country. It is probable that the time elapsing between inoculation and the appearance of a visible sore is very variable, and may depend on several factors, such as a person's natural resistance to the disease and his general health at the moment of infection. The parasites may have been multiplying slowly in the skin at the point of inoculation, and have produced no visible reaction, or one which is so slight as to be overlooked. It is difficult to fix a point up to which the period of incubation is to be reckoned.

Recently, I have attempted inoculation in human beings, but these experiments are not yet complete.

Character of the Sore.—Locally it is believed that there occur two kinds of sore, which are designated male and female. Clinically this is true. As the types of two extremes there exist the ulcerating and the non-ulcerating sores. The ulcerating or, as it is known locally, the female sore, commences as a red papule, the surface of which soon breaks down, leaving a shallow indolent ulcer from which a yellow fluid exudes carrying with it the typical date boil parasites and the numerous bacteria with which these ulcers become secondarily infected. The ulcer gradually extends till in very severe cases a large area may be involved. In one case encountered the ulcer occupied the whole of one cheek, had destroyed the lower eyelid of that side, and had extended across the bridge of the nose to the other cheek. When small, these ulcers frequently scab over, but the scab is easily removed, and when left only serves to retain pus, and

to make the sore painful. In these spreading sores one often finds that one part of the sore heals while it is still extending in another direction. When these ulcers heal they leave the superficial large scars known as the "date mark," seen so commonly on the faces of the Bagdad inhabitants. It is very rarely that any deformity results from contraction of these superficial scars.

The male, a non-ulcerating sore, commences also as a papule of a characteristic reddish-brown colour, and covered with shiny epidermis. It increases in size very slowly, and shows very little or no sign of ulceration. A scaly scab may form at the centre of the date boil. This scab may fall off naturally or be removed, when there is again left the reddish-brown shiny skin beneath. On puncturing such a date boil one obtains a pure culture of the date boil parasite free from any admixture with other organisms. It is from such sores that the cultures to be described below have been obtained. At any time the centre of one of these non-ulcerating sores may break down and give rise to an ulcer, which may become secondarily infected and extend as the female sore.

Duration of Disease.—The duration of the disease is usually about one year, with a variation of about three months on either side of this limit. The sore may remain as in the "male sores" without ulceration at any stage of its existence. It remains a papule which increases in size, becomes stationary, and finally shrinks till it completely disappears, leaving a reddish-brown coloration of the skin which gradually fades away. The scars left by these sores are never so deep as those of the ulcerating type, where infection with other organisms is a constant feature of the disease. The organisms found in the ulcerating sores are streptococci, staphylococci, various bacilli, and frequently a diplococcus resembling very closely the gonococcus, in that it occurs in pairs within the pus cells. This latter organism I have found on several occasions in a subacute ulcer which frequently

attacks people in Bagdad, and which might readily be confused with the true date boil. It is worth while remarking that on no occasion have I encountered spirochætes in the scrapings of these ulcerating date marks.

Immunity.—After the date boil has healed, the person is protected completely from further attacks. I have been told of persons who have had a second, and even a third, attack, but if such cases occur they must be extremely rare. The consensus of opinion amongst the inhabitants of Bagdad is that a second attack is impossible, and the exceptions are so few that this opinion is substantially correct. Sometimes while a date boil is developing on one part of the body a second will begin at some other point perhaps six months after the commencement of the first. This merely shows that the immunity is not yet complete. In one case an Englishman suffered from a sore on the right wrist for about one year. It disappeared when a second sore developed on the left elbow, and this lasted for another year. Some cases have been recorded of persons who have suffered from the Aleppo boil contracting the Bagdad boil on coming to this town. With these few exceptions the single attack lasting about one year is the rule, while the healing of the sore appears to be brought about by an immunity against the specific organism acquired by the person infected, such an immunity being of sufficient duration to protect the person from further attack for the rest of his life.

Treatment.—It is very doubtful if any treatment at present attempted has been of avail. Excision of the sore has been attempted and with success, but such a procedure would probably leave the patient non-immune and open to further attacks. Various ointments and lotions have a certain reputation in Bagdad, but they do little or nothing to lessen the duration of the disease. I have been giving the yellow mercury ointment of the B.P., and some have declared it to have produced a cure in a few days.

The majority of the people are very dirty, and as I insisted that before the application of a fresh supply of ointment to the sore, the old ointment must be carefully washed off, this treatment at least has had the virtue of keeping the sores clean, and in this way alone may have been of benefit.

Symptoms.—Apart from purely local symptoms due to the sore it is impossible to trace any constitutional disturbance. The fact that nearly all sores are in very young children makes the selection of such symptoms difficult, as any slight disturbance in health can at this age be attributed to the common ailments of childhood. Again, the onset of the disease is so insidious that the appearance of the first papule is not considered to be a date boil, till by its persistence the patient recognizes its nature. Slight fever, feeling of malaise or intestinal derangement, which might be due to the infection with the organism of the date boil, would most probably be looked upon as one of those slight disturbances so common in all hot countries. In the case mentioned above, of the child with twenty-three sores, there was nothing to indicate, apart from the sores, that the child was in any way abnormal. The child was well developed and well nourished, and showed every sign of enjoying life completely. It has been suggested that this disease is a general one, and that the sore is merely a local manifestation of a general infection, as in the case of the syphilitic chancre. If this be true there is, however, this difference: whereas the chancre in syphilis indicates a very severe general infection accompanied by various symptoms, the date boil is accompanied by no such constitutional disturbances or such as are too slight to be detected.

The impossibility of performing autopsies in Bagdad is a misfortune, as from this source much light may be thrown upon the disease. Repeated examinations of the blood of infected persons have failed to confirm the observation of Neumann that parasites may occasionally be found in the peripheral blood. Like-

wise the attempts made to obtain cultures from the peripheral blood have met with no success. These observations and experiments might be continued however.

The local symptoms are due to the presence of the sore. As a rule there is little accompanying pain, and the sores are not remarkably tender. Occasionally where the sore has formed over a bone, as the tibia or on the elbow, the sores are tender and painful, but this is the exception. The discharge from the ulcerating sores is often very foul and exceedingly unpleasant, not only for others, but for the patient himself, who frequently is unable to remain in a room, but has to seek refuge in the open air. The painlessness of the date boil is well illustrated by the case of a man who had two on the foot for about one year. In spite of the sores he was able to wear his ordinary footwear, to walk, ride, and take other forms of exercise without inconvenience.

I am unable to give any information as to the occurrence or otherwise of kala-azar in Bagdad. The staff of the English medical mission at Bagdad have not met with the disease. If the disease occurs it has not yet been diagnosed as such. I have seen several cases with enlarged spleens and livers apparently not malarial. It is possible that some of these may have been kala-azar, but a blood examination alone did not throw any light on the condition.

(2) Examination of Lower Animals for Signs of the Disease and Inoculation of these from Man.

Dogs.—The commonest domestic animal living in close association with man in Bagdad is the dog, which lives upon the refuse of the houses thrown out upon the streets. There is a general opinion that the dogs suffer from the date boil about the nose. Cases of dogs with these supposed sores on the nose have been difficult to find, and were not nearly so common as they were supposed to be. Several cases were,

however, discovered, but unfortunately in none of these could the parasite be found. One large dog had an ulcerating condition of the legs which had been regarded as date boil, but repeated examinations of this have failed to reveal the parasite. All these cases were in pet dogs living in private houses. Examination of a large number of street dogs has shown that ulceration about the nose is very uncommon amongst them, though they often have wounds on the head, the result of their constant fighting.

Quite recently the authorities in Bagdad have followed the example of Constantinople in taking steps to exterminate the dogs from the streets. Accordingly all street dogs have been collected and herded together in an enclosure in the desert, where they are kept in a condition even less sanitary than that in which they lived before. These dogs died off rapidly, and I obtained permission to perform autopsies on them. Up to the present I have examined the organs of about eighty dogs, and at the same time have kept a careful look-out for any sign of date boil. I have not been able to find the parasite of the date boil in a single instance, so that if the dog acts as an alternative host for this parasite, it is only a very small percentage of dogs that is infected. Further, if it be true that the dog acts as a kind of reservoir for the parasite which is handed on to man by some biting fly, then the incidence of date boil amongst the population of Bagdad should considerably diminish now that all the street dogs have been removed. Time alone can give the result of this experiment.

Nearly every dog examined is found to harbour a hæmogregarine in its leucocytes, and the reproducing forms are constantly present in the spleen and bone-marrow.

Piroplasmosis is common, occurring in perhaps 5 per cent. of the dogs.

The dogs are covered with ticks and fleas, and

also a fly belonging to the Hippoboscidæ. All of these will draw blood from man, the latter, however, rarely.

Cats.—Cats in Bagdad, like the dogs, live in semi-domestic condition. I have not been able to examine more than one of these animals, and the result of this examination was negative.

Rats.—Rats are exceedingly common and a great pest. Examination of numbers of these has only revealed the common *Trypanosoma lewisi* and the hæmogregarina occurring in the leucocytes.

Inoculation of numbers of rats with date boil material has given no result.

Rabbits.—Similar experiments conducted on rabbits have likewise failed to give any result.

Birds.—Sparrows and two small owls have been inoculated without success.

Ticks.—An attempt has also been made to obtain a development of the parasite by inoculating the large blown-out ticks taken from dogs. The ticks survived the operation of inoculation, but no trace of any development of the parasites could be found.

Other domestic animals in Bagdad are the horse, mule, donkey, and cattle. Camels are rarely seen in the town, and then only in passing through the town from one gate to another. They are always left without the town in the desert. It is unlikely that any of these animals have any influence on the disease as it occurs in Bagdad.

The failure to obtain an animal suitable for inoculation experiments has proved a great obstacle to the work. With an animal reacting easily to inoculations, as so many animals do to pathogenic trypanosomes, the work would be much simpler, whereas now experiments with flies can only be tested by dissection and search for developmental forms of the date boil parasite, a procedure which is much more difficult and full of pitfalls than the experiment of transmission.

(3) Examination and Dissection of Flies and Ticks.

Biting Flies.—Before naming the true biting flies some remarks must be made on the common house fly, which, as would be expected, occurs in myriads. It is constantly swarming over the faces of the children, and especially those made attractive by the presence of the date boil. From an examination of the flies taken off the sores I have demonstrated that the parasites are being continually taken up, and are to be easily found in the gut directly after feeding. It must certainly come about that the house fly acts on occasions as a simple carrier of the disease to open wounds. Only in this way can be explained some of the cases in which wounds incurred upon the face, arm, and leg, have ultimately developed into date boils. Or, as sometimes happens, the wounds completely heal, and later a date boil develops at this spot.

Stomoxys.—From the time of my arrival in Bagdad in March, till the hot weather had set in in June, these flies occurred in fair numbers, especially in the neighbourhood of the stables. They often settled upon one and were mistaken for ordinary house flies till the pricking of their proboscis revealed their nature. They would frequently bite through socks. With the advent of the really hot weather these flies almost disappeared, and could rarely be discovered even in the stables, their favourite haunt. These flies feed normally upon the horses, mules and donkeys.

Hippoboscidæ.—Flies belonging to this group are to be found commonly on the horses. Another is seen constantly on the dogs, where it hides buried in the fur till disturbed, when it leaves its host or flies to hide on some other part of the body. These flies will sometimes bite human beings, but this is a rare occurrence. I have been bitten only on two occasions, though I have been living in close association with a number of dogs, all of which had many of these flies about them.

Tabanidæ.—Flies of this genus, Tabanus, I have not encountered in Bagdad, but I have seen one taken a mile or two out of the town.

Fleas.—Fleas are a great pest, and especially at a certain season of the year, which is popularly known as the flea season. The season is the month or two before the commencement of the summer or season of intense heat. They are constantly on one's person, and give one no rest. With the hot weather they completely disappear.

Body-lice.—These are found commonly on the bodies and clothes of the dirty part of the population of Bagdad.

Ticks.—Ticks are found on practically all the domestic animals. They, however, rarely attack man. The dogs in the streets are usually covered with them.

Bed-bugs.—Bed-bugs occur in Bagdad, but in no great numbers. They can usually be obtained fairly easily in the prison, where they hide in the mats used to cover the floor, or upon which the prisoners sleep. In only one other house have I heard of the occurrence of bed bugs, and then only in small numbers. It is certain that Bagdad is not infected with bed bugs to anything like the extent of some other Eastern cities. It is possible that the dryness of the atmosphere, combined with the intense heat, is unfavourable to their development.

Sand-flies.—Sand-fly is a name used here for any small fly that bites at night. I have not encountered a true sand-fly in Bagdad. The fly usually described by this name is a Phlebotomus. It is able to pass through the meshes of the mosquito net, from which it escapes in the morning after feeding. I have only been able to secure very few of these flies, as they are exceedingly difficult to capture.

Mosquitoes.—These occur in large numbers. In those years that the river overflows its banks and runs into the desert around Bagdad, forming pools and marshes, the mosquitoes are said to occur in greater numbers than I have seen. Before the hot weather has set in, from March to June, various species of *Culex* were very common. Amongst these was the

common *Culex fatigans*. The other species have not yet been identified. With the advent of the hot season the number of *Culex* began to diminish, while another mosquito, *Stegomyia* sp., increased in numbers. This mosquito lives in the houses and hides in any dark corner, especially the sirdarbs, or semi-underground rooms, into which one retires at the hottest part of the day. The Stegomyia is most persistent in its attack, and is a constant worry during the day Both the male and the female suck blood, but the females more vigorously. A female mosquito will readily feed every day, and forty-eight hours appears sufficient time for the digestion of the large quantity of blood taken at a single feed. During the hot weather these mosquitoes increase in numbers, till at the end of September they are at their maximum. They breed, as do other mosquitoes, in the wells and "hubs" or native filters of porous earthenware found in every house in Bagdad. During the hot weather the growth is very rapid, and one week is almost sufficient for the complete development of the mosquito from the egg.

Dissection of, and Experiments with, Flies, Ticks, &c. —The ordinary house-fly commonly harbours the flagellate Herpetomonas in its gut. It is difficult to give any definite percentage for infected flies, as the number of infected individuals in different batches varies considerably. It is possible that more than one species of Herpetomonas is to be found in the house-fly. A Crithidia was found on several occasions to inhabit the Malpighian tubes. As mentioned above, these flies constantly feed on the date boils, and the parasites can be demonstrated in the gut soon after feeding. So soon as six hours after feeding on the sore I have failed to detect the parasite in the gut. A large number of experiments have been conducted to trace any development of the date boil parasite in the fly's gut, but without success. Two series of flies, consisting of ten each, were fed in the following way ;—

One series was allowed a daily feed of fresh human

blood, the second series was fed on the scrapings of a date boil. After ten feeds in this manner the flies were dissected. The result was that in those that had fed from the sore no trace of the date boil parasite or other flagellates could be detected, while amongst those that had fed upon human blood one had a Herpetomonas, probably *H. musca domestica*, in its gut. From this and other experiments it appears that the date boil parasite does not develop in the house-fly. I have not been able to determine whether the parasite is passed unharmed through the gut of the fly. Examinations of the excreta have given no definite result.

Stomoxys feed readily off the sore each day but the results of such feeds have been negative. This fly occasionally harbours a Herpetomonas, evidently a parasite peculiar to itself.

Large numbers of the dog-fly (Hippoboscidæ) have been dissected, but no flagellates were found in them. It was impossible to keep these flies in captivity, nor could they be induced to feed from the date boil. A dissection of the fleas and body lice have likewise given no result in the way of a flagellate infection.

With bed bugs obtained from the prison experiments were made. The bugs were allowed to feed upon the sore, and were dissected at varying intervals after feeding as had been done in all feeding experiments. In a certain number of these, flagellates of the Herpetomonas type were found in the gut forty-eight hours after feeding.

The resemblance of these flagellates to the cultural forms of the date boil parasite is very close, and since a dissection of a considerable number of bugs, which had not fed on the sore, has failed to reveal any flagellate infection, it is probable that this Herpetomonas represents a culture of the date boil parasite in the gut of the bed bug. The distribution of the bed bug in Bagdad is so restricted that it is impossible for it to be the true carrier of the date boil. It is more probable that the large quantity of blood taken

into the stomach had served as a good culture medium in which the date boil parasites were able to develop.

This observation is very similar to that by Patton on the development of the parasite of kala azar in the same insect. If the parasite of the date boil can develop into a flagellate in the stomach of an insect, not its true host, then it would be expected that the very similar parasite of kala azar would develop in the same manner. Such experiments and results only show that it is unsafe to draw the conclusion that an insect showing such developmental stages is the true carrier of the disease. The development is probably merely a partial imitation of what would actually take place in the true intermediate host.

A large number of experiments have been conducted with mosquitoes, which in nearly every instance have been hatched in the laboratory. With the various species of *Culex* there was no result. It was exceedingly difficult to induce them to feed upon the sore, and it was only rarely that one would feed more than twice. However, a sufficient number were experimented with to show that no development of the date boil parasite was to be traced in them. With Stegomyia the feeding was much simpler. They fed readily in broad daylight, and were eager to feed upon the sore every day. It was determined that these mosquitoes had taken up parasites by dissections made immediately after feeding. These mosquitoes were allowed a varying number of feeds, and dissected as a rule twenty-four or forty-eight hours after the last feed. A large number of experiments have been conducted, and in four instances Herpetomonas have been found in the mid-gut. These bear a close resemblance, as in the case of the bed bugs, to the cultural forms of the date boil parasites. The hind gut was in every case free from flagellates, and this fact is perhaps in favour of these flagellates being derived from the parasites taken up at the feeds, for as a rule an insect having a natural flagellate infection has the infection limited entirely or most marked in

the hind gut. It is very difficult to obtain a definite proof that these flagellates have developed from the date boil parasites. Up to the present Stegomyia fed on human blood free from parasites have failed to reveal any flagellates on dissection. The examination is still in progress.

All these feeding experiments have been conducted upon a case of date boil in a boy. The sore was of the non-ulcerating type, and covered with thin red skin. Puncture of the sore gave a pure culture of the specific parasite free from any other organisms.

Very commonly a Gregarine is to be found, in the encysted and spore stage, within the Malpighian tubes of the Stegomyia. The complete life-cycle of this Gregarine has been traced. The free Gregarines live in the intestine of the larvæ, where they are seen hanging from the endothelial cells. As the larva changes to the pupa so the Gregarines migrate into the Malpighian tubes, and commence encystment in pairs. By the time that the mosquito emerges from the pupa the complete development has taken place, and the characteristic spindle spores are to be found in the Malpighian tubes. Evidently these spores escape into the water and re-infect the young larvæ with their food.

Occasionally the larvæ of *Stegomyia* sp. have an infection of Herpetomonas in the Malpighian tubes. It is possible that the flagellates found in the mid-gut of the adult mosquito after feeding on the date boil are derived from these. However, no case of flagellate infection of the pupa has yet been met with, though very many have been dissected.

The gut of the larvæ is almost always teeming with Spirochætes.

Unfortunately, up to the present it has been impossible to secure sufficient specimens of Phlebotomus for experimental work.

Character of the Parasite as found in the Sore.—The parasite in smears from the sore varies very much in size and shape from the classic oval parasite with the

deeply-staining rod and paler nucleus. The typical oval parasites are found in large numbers, but in addition to these are many smaller forms occurring mostly outside the cells. As Dr. Row has figured them they are frequently pointed at one end, while the micronucleus lies close against the macronucleus. In the pointed forms the micronucleus is almost invariably on the side away from the pointed extremity, a fact which seems to indicate that this pointing is not a stage in the direction of flagellum formation as one is inclined to suppose. The protoplasm of the body of the parasite is usually vacuolated, while the fine red staining line running from the micronucleus to the surface of the body is often seen, especially in the larger forms. This red line is without doubt the rhizoplast, root, or intra-protoplasmic part of the flagellum. I have not been able to trace any change undergone by the parasite with the growth of the sore. All forms are to be found in both young and old sores. Parasites without nuclei, or with only a micronucleus or macronucleus, are frequently seen. These are probably degeneration forms. The case of admixture with other organisms in the ulcerating sores has been mentioned above. As is well known, the parasites, when intracellular, are found in the large mononuclear cells which are often full of parasites, and have their nuclei broken up by this invasion. When other organisms are present, and there is a purulent discharge, the parasites are taken up by the polymorphonuclear leucocytes.

Culture of the Parasite.—The parasite has been successfully cultivated on several occasions. The first attempt was made with a medium prepared after the formula of the rabbit blood agar of Novy and MacNeal, with the difference that dog's blood was substituted for the rabbit's blood. After several failures, due to contamination, a successful result was obtained from a boil on a child's face. Sub-cultures were made from this upon rabbit blood agar and dog blood agar. Development in the rabbit blood medium was much

more rapid, and on this the culture was maintained for several months. The cultures upon the dog's blood medium eventually died out. The development of the parasite followed closely the description given by Dr. Row of the cultures of the parasite of Oriental sore.

Inoculation of these cultures into various animals has given no results. The parasites, both in smears of the sore and from cultures, have been stained by various methods. Giemsa's method of wet fixing and staining has been tried, and films have been fixed in Schaudinn's fixative and stained with Heidenhain's hæmatoxylin, and also with ordinary alum hæmatoxylin. Both in the parasites from the sore and from the cultures the nucleus was found to have a structure very different from that appearing on films stained by the drying methods. The nucleus consisted of a spherical or oblong body limited by a delicate membrane. At the centre of this is a deeply-staining karyosome appearing red by Giemsa's method and black after Heidenhain's hæmatoxylin. The nucleus of this parasite is, therefore, constructed on the same lines as the nuclei of the trypanosomes. In nuclear division the karyosome first divides by becoming elongated and finally constricted at the centre; the micro-nucleus stained as a round or rod-shaped body surrounded by a pale area. The flagellum in the flagellated forms was traceable to a point close to the micronucleus, but it does not unite with it.

In multiplication by division the flagellum of the divided-off parasite appears to be a new formation growing out from the micronucleus, and is not formed by splitting of the already existing one.

Origin of the Disease.—There are many local theories explaining the origin of the disease. Some maintain that it is only those who drink the water of the Tigris or Euphrates who become infected, others that it is due to the contamination of open sores by dust from the roads, while some believe it to have some kind of relationship to syphilis. The names "date boil" and

"date mark" are the result of another theory attributing the disease to the dates which become ripe just at the season of maximum incidence of the disease. None of these theories will explain the disease. On account of the peculiar distribution of the sore, the character of its parasites, and the development of this into Herpetomonas in the culture tube, the only tenable hypothesis is that some biting fly transmits the infection. The possibility of the house-fly acting as a mechanical carrier of the disease has been mentioned above. That this mechanical transmission is to be regarded as the normal means of infection cannot be maintained. That it can act in any other way than a mechanical carrier is disproved by the failure of the parasites of the date boil to develop into flagellates in their intestines, and the quick disappearance of these when taken up from the sore. These statements are, of course, based on the assumption that the culture one obtains in the test-tube is at least a picture of what is to be found in the intestine of the true intermediate host. That this is probably correct is borne out by the fact that a partial development will take place in the intestine of the bed bug.

The Stomoxys as the carrier of the disease is not to be suspected, as it not only is limited in its distribution, occurring, as already stated, mostly in the neighbourhood of the stables, but it also fails to give any development of the parasite in its gut even after as many as ten feeds from the sore.

The bed-bug, on account of the development of the kala-azar parasite taking place in its gut, and its supposed responsibility for the spread of this disease, was at first looked upon with suspicion. It was soon found that its distribution in Bagdad was too limited to account for the disease; and further, it would not explain the occurrence of sores only upon exposed surfaces of the body. In spite of the impossibility of the bed bug being the host of the date boil parasite a certain development of the parasite takes place in its

gut. This observation is of great importance, as it shows that the development of the kala azar parasite, which was found by Patton to take place in the same host, may be of a similar nature. The evidence of such a development is insufficient to prove the bed bug the intermediate host. There is a possibility, in my experiments as well as in Patton's, that the flagellates seen in the bed-bugs are parasites peculiar to these insects. A dissection of numbers of bed-bugs which have not taken up date boil parasites has at least tended to disprove this view. It seems, therefore, that the large quantity of blood taken up by these insects when they bite is able to act as a culture medium for these parasites, without this culture indicating in any way that the development is the true development in an intermediate host.

The Hippoboscidæ, the ticks, the fleas and body-lice will not explain matters. The two former on account of their seldom attacking man, and the two latter because they would give rise to sores more frequently on the unexposed rather than on the exposed surfaces of the body.

The only other biting flies of any note in Bagdad are the mosquitoes and the so-called sand-flies. Of the mosquitoes only the Stegomyia can be suspected. In the various species of *Culex* no demonstrable development of the parasites has taken place. On the other hand various facts would point to the Stegomyia. This mosquito is essentially a house mosquito, and is most persistent in its attempts to obtain a feed of human blood. When it has completed its fill of human blood it quickly digests this apparently enormous quantity, and is ready on the next day for another feed. It bites as readily by day as by night, so that one is never free from its attacks. Further, with the commencement of the hot weather this mosquito increases in numbers till at the end of September it is at its maximum. This corresponds with the season of maximum prevalence of the date boil, which, as before mentioned, is in the

month of October. In addition to this evidence, in a certain number of these mosquitoes fed from the date boil flagellates have been found in the stomach forty-eight hours after feeding. It is not quite certain that these represent developmental stages of the date boil parasite, and even if they do their numbers and character resemble the condition found in the bed-bug, and is not the extensive development one would like to find. However, experiments of transmission with this mosquito have been done upon a resident in Bagdad who has not yet suffered from the date boil. It is still too early for any result. It would thus appear that there are many points in favour of regarding the *Stegomyia* sp. as the transmitter of this disease, and if it were not for the presence of the sand-fly (Phlebotomus) the evidence would be still greater. This small fly attacks during the summer months, but has not been secured in numbers sufficient for experimental work. It bites especially on the roof at nights, where all Bagdad inhabitants sleep during the hottest weather. I am unable to give any facts in support of this fly being the host. It has been suspected in other places where this disease occurs. In Bagdad, however, in numbers and ferocity it does not approach the Stegomyia. This, however, is no evidence for or against its accusation.

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